

MEMORANDUM FOR: Clifton S. Middleton
Project Director, Survey Section B

FROM: Charles W. Challstrom
Director, National Geodetic Survey

SUBJECT: INSTRUCTIONS: MASSACHUSETTS, CONNECTICUT, AND
RHODE ISLAND FBN, 2000 (GPS-
1514)
Task Numbers: 8K6D2000 (FBN)
8K6D4000 (CORS FBN/CBN TIE)

GENERAL:

The National Geodetic Survey (NGS), in accordance with the NGS Strategic Plan, is engaging in a campaign of observing stations of the Federal Base Network (FBN) to complete the ellipsoidal and orthometric height components of the FBN. This survey will observe the 9 FBN stations in Massachusetts, the 4 FBN stations in Connecticut, and the 1 FBN station in Rhode Island.

In Massachusetts, FBN stations HAYSTACK OCP 3 and PROSPECT TAUNTON have been found unsuitable for GPS occupation and have been replaced by stations A 56 (PID AA3508) and MANSFIELD (PID LW5147), respectively.

In Connecticut, FBN station MERIDEN was found unsuitable for GPS occupation and was replaced by station MMK A (PID AI5589).

In Rhode Island, station CENTRAL was found unsuitable to serve as a FBN and was replaced as a FBN by station CHETEYAN (a new station).

At one locale in Massachusetts, station CHATHAM LIGHT USCG (PID AB2629) was chosen as a FBN over station CHATHAM USCG.

In Massachusetts, stations Y 30 (PID MY0497) and Z 39 (PID MZ1129) have been included in the project to serve as bench mark ties only. Likewise, in Connecticut, stations D 92 (PID LX3066) and ZIEMBA (PID LX2642) have been included to serve as bench mark ties only, as well.

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In addition, at the Westford, Massachusetts, and Naval Station Newport, Rhode Island, Continuously Operating Reference Stations (CORS), a pair of CORS reference marks at each site is to be tied to both the local FBN/CBN and the CORS antenna. Details are given under SPECIFICATIONS.

Lastly, a station at each of seven tide sites in the three states is also included in the project and is to be surveyed to FBN specifications. In Massachusetts, the tide sites are Boston, Woods Hole, and Nantucket. In Connecticut, the tide sites are Bridgeport and New London. In Rhode Island, the tide sites are Providence and Newport.

A full-wavelength, dual-frequency Global Positioning System (GPS) receiver is needed to act as Central Temporary CORS (CTCORS) throughout the project. The receiver shall be deployed at relatively secure stations within the vicinity of the ongoing observing sessions. The receiver shall continuously collect data at a 30-second epoch collection interval for a minimum of 72 hours and for as long as observations are ongoing in the vicinity of the CTCORS.

In Massachusetts, approximately 45 Cooperative Base Network (CBN) stations will be co-observed by up to 17 different organizations. The CBN coordinator there is Mr. Curt Crow, NGS State Geodetic Advisor.

In Connecticut, approximately 17 CBN stations will be co-observed by the Connecticut Department of Transportation. The coordinator for this is Mr. Bob Baron, Connecticut Department of Transportation.

In Rhode Island, approximately 16 CBN stations will be co-observed by up to 8 different organizations. The CBN coordinator there is Ms. Kathy Cheteyan, Rhode Island Department of Transportation.

The project will be performed under the technical management of NGS.

PURPOSE:

In order to meet America's accelerating positioning and navigation needs, the existing coordinate reference system must be continually enhanced to provide the accessibility and high accuracy required for use with GPS. The digital

revolution in mapping, charting, and surveying requires a National Spatial Reference System (NSRS) consisting of, among other components, a network of monumented points having four-dimensional positions. The FBN fulfills the requirements for this component. NGS is charged with the Federal responsibility for establishment, observation, monitoring, and maintenance of the FBN. The FBN provides the critical network foundation for an accurate, consistent, reliable NSRS.

The NSRS, in turn, provides the common geographic framework for America's spatial data infrastructure. As such, the NSRS serves as the basis for mapping, charting, navigation, boundary determination, property delineation, infrastructure development, resource evaluation surveys, and scientific applications, including crustal motion monitoring, modeling of flooding, storm surge, pollution trajectories, and agricultural runoff. A modernized, accurate, consistent, reliable NSRS is of enormous benefit to state, county, tribal, local, and Federal authorities, as well as to the private sector.

The reference marks established at each of the two CORS sites will provide a very accurate tie to the antenna as an aid to reposition the antenna should that become necessary. The FBN/CBN tie to the reference marks will also provide site station coordinates relative to the local FBN/CBN, thus reducing the potential for relative error between the reference marks and the local network. It will also provide a check on the FBN/CBN, relative to the CORS coordinates.

The seven tide site surveys will provide GPS-derived ellipsoid heights, accurate to 2 cm, on tide site water level marks along the Atlantic Ocean coast.

SPECIFICATIONS:

Project requirements for the FBN observations are to ensure 2-centimeter local accuracy in the horizontal component, as well as 2-centimeter local accuracy for the ellipsoid heights.

Data from the CORS in the region are to be used in the processing. There are ten National CORS in the area to be selected from. Two each are in Massachusetts, New York, and New Jersey. One each is in Vermont, New Hampshire, Pennsylvania, and Rhode Island.

Also, there are community base stations in Concord, New Hampshire; Woburn, Massachusetts; Newington, Connecticut; and Providence and Kingston, Rhode Island. These base stations should be used as CTCORS, if possible, and Cliff Middleton, Survey Section B of NGS, will inquire as to their suitability as such.

The ten National CORS are Westford (WES2) and Chatham (CHT1) in Massachusetts; East Moriches (MOR1) and Syracuse (SYCN) in New York; New Jersey IT (NJIT) and Sandy Hook (SHK1) in New Jersey; Vermont Capital (VCAP) in Vermont; Portsmouth (POR4) in New Hampshire; Wilkes Barre (WIL1) in Pennsylvania; and Naval Station Newport (NPRI) in Rhode Island. Note that Westford is an International GPS Service (IGS) station and should definitely be used in the processing.

Positions for and data from the National CORS are available from the NGS web site. For data from the Concord, New Hampshire, community base station, contact Mr. Kerrie Hartshorn, New Hampshire Department of Transportation (listed under LIAISON). To obtain data from the Woburn, Massachusetts, community base station, contact Mr. Jim Bosworth, Maine Technical Source (listed under LIAISON). For the Newington, Connecticut, community base station, contact Mr. Bob Baron, Connecticut Department of Transportation (listed under LIAISON). For the Providence, Rhode Island, community base station, contact Ms. Kathy Cheteyan, Rhode Island Department of Transportation (listed under LIAISON). For the Kingston, Rhode Island, community base station, contact Mr. Chuck LaBash, University of Rhode Island (listed under LIAISON).

General specifications for the project are as follows. At each FBN and CBN site, three sessions of 5 1/2 hours duration for each session shall be observed. The observing scheme shall be arranged so that for each station, the start time of one of the observing sessions shall be at least 4 hours different from the other two. The observing scheme shall be arranged to ensure that adjacent FBN and adjacent CBN stations are directly connected in at least one observing session, and at least half of all base lines are repeated.

Specific to the Westford and Naval Station Newport CORS sites is that for the two reference marks at each site, two sessions of 2 hours each shall be observed. In order to provide a check, the equipment shall be broken down and reset with a

minimum of 30 minutes between the two sessions. Since the CORS sites are to be tied to the nearest FBN/CBN station, the FBN/CBN station must be occupied simultaneously with the two reference marks. If the occupation of the FBN/CBN tie station is ancillary to the project, observe the two 2-hour sessions there and break down the equipment as described above. If the occupation of the FBN/CBN tie station is part of the general FBN/CBN sessions, occupy the station for the entire 5 1/2-hour session with no equipment breakdown.

Specifics for the CORS sites are as follows:

- (1) For the Westford CORS, the reference marks are WES2 A (new station) and MILL (PID MY2204). The FBN/CBN tie station to use is ZBW B (PID AA3501), a FBN tie. If a backup tie station is needed, contact Doug Hendrickson, N/NGS21 (listed under LIAISON).
- (2) For the Naval Station Newport CORS, the reference marks are NPRI A (new station) and NPRI B (new station). The FBN/CBN tie station to use is CENTRAL (PID LW0418), a station that is serving as a CORS tie only. If a backup tie station is needed, contact Doug Hendrickson.

In general, station occupation and observing procedures must be carried out according to appropriate sections of the "NGS Operations Handbook" and the current applicable receiver field manuals. Data formats and digital file definitions are given in "Input Formats and Specifications of the National Geodetic Survey Data Base," Volume I. Horizontal Control Data, Federal Geodetic Control Subcommittee, September 1994, revised and reprinted November 1998. Success in meeting the accuracy standards will be based on repeatability of measurements and adjustment residuals.

General specifications for the project are given in "Geometric Geodetic Accuracy Standards and Specifications for Using GPS Relative Positioning Techniques," Version 5.0: dated May 11, 1988, reprinted with corrections August 1, 1989. Specific project criteria and deviations from the general specifications are given in the following sections.

Project Network - A list (Table 1) and sketch of stations involved in this project will be provided.

Data Acquisition - Data collection must be accomplished as specified in the appropriate dual-frequency receiver field manuals in the compressed mode at a 15-second epoch collection interval. The GPS receivers must be dual-frequency and full-wavelength. Track satellites down to a 10-degree elevation angle.

The satellite observing scenario will be provided in Table 2. Sessions will generally begin at two observing windows at least 4 hours apart - 1300 UTC and 1730 UTC. The observing windows will shift in weekly increments of 30 minutes instead of daily increments of 4 minutes. Vectors between the project stations shall be measured by single sessions consisting of continuously and simultaneously tracking for 5 1/2 hours.

Each FBN station must be occupied at least three times - twice at one observing window and once at the other. Each FBN station must be tied to two different bench marks. This bench mark tie requirement can be satisfied in one or two sessions. Adjacent FBN stations must be directly connected in at least one observing session, and at least one-half of all FBN base lines must be repeated. The CORS base lines will be repeated. CORS and CTCORS data will be used throughout the project.

For this project, each CBN station must also be occupied three times as described above. However, CBN stations can be tied to adjacent FBN stations if the FBN station is closer than an adjacent CBN station. The repeated-base line requirement also applies to the CBN, although a base line consisting of a CBN station and a FBN station (instead of two CBN stations) can also be used. The two bench mark tie requirement also applies to the CBN.

Record weather data just before, immediately after, and at the mid-point of each session. Meteorological data shall also be collected immediately after an obvious weather front passes during a session and immediately before it passes, if possible. Pressure and relative humidity measurements must be made near and at about the height of the GPS antenna phase center. Indicate in the log the location of the barometer and psychrometer.

Survey operations shall be conducted with due regard to the safety of personnel and equipment. Contact with the airport traffic control tower is mandatory during surveys at any controlled airports.

Vector Computations - Data management, quality review of collected data, and final vector processing for the FBN/CBN survey will be accomplished using PAGES. Vectors shall be computed in the International Earth Rotation Service Terrestrial Reference Frame (ITRF) system, using the most current epoch and precise IGS ephemerides. Use 30-second epoch intervals for data processing. Monument positions will be used for CORS when available, otherwise, antenna reference point (ARP) positions will be used. Ms. Vasanthi Kammula, N/NGS23, will be responsible for the processing of Massachusetts, Connecticut, and Rhode Island.

The data will be processed in 24-hour sessions (or slightly longer if the observation session crosses 0000 UTC) in order to utilize the 24-hour data sets collected at the CORS and CTCORS. The "fixed baseline" option in PAGES will be used to compute direct baselines between the CORS and CTCORS. The "fixed baseline" scheme will depend on the location and reliability of the CORS and CTCORS used in this project.

For stations where weather data are not available, or are suspect, predicted values will be computed and used based on the station's latitude, height above mean sea level, and time and day of year. Use 15 degrees as the cutoff elevation angle in data processing. A cutoff angle of 10 degrees may be used when necessary to improve results.

The type of final solution, L1 versus ion-free, will depend on the length of the vectors. For vectors which are less than 10 km in length, the final reduction will consist of a L1 fixed solution. These vectors will be computed in a separate processing session from the longer vectors computed in an ion-free solution.

In general, vectors greater than 10 km in length are to be computed in an ion-free fixed, or partially-fixed, solution. In all cases, integer ambiguities will be fixed for each vector whenever possible.

For the Naval Station Newport and Westford CORS reference marks, the CORS antenna at each site will be used as the reference station in the data processing.

The quality of collected data shall be determined from the plots generated from PAGES, by analysis of repeated vectors and/or comparison of station positions, and free adjustment residuals and/or loop misclosures. In addition, a constrained adjustment constraining all CORS will be performed.

Survey Section B will perform all quality checks for conformance with NGS format standards such as executing software programs COMPGB, OBSCHK, and OBSDES. The final ITRF vectors will be assessed and transformed to the NAD 83 coordinate system using program ADJUST.

The data and results will be submitted to the Observation and Analysis Division. All B-files and G-files must be complete, including *25* and *27* records.

Station Descriptions - Station recovery notes must be submitted in computer-readable form using DDPROC software. Include the name, address, and, if public ownership, the telephone number of the responsible party. Do not include the telephone numbers of private property owners.

Special Requirements - Antenna set-up is critical to the success of this project. Fixed-height tripods are preferred for all receivers. The plumbing bubbles on the antenna pole of the fixed-height tripod must be shaded when plumbing is performed. They must be shaded for 3 minutes before checking and/or re-plumbing. Also, the perpendicularity of the poles must be checked at the beginning of the project and any other time there is suspicion of a problem.

When a fixed-height tripod is not used, the height of the antenna must be carefully measured to prevent station set-up blunders from occurring. Tribrachs used for these set-ups must be checked and adjusted when necessary. Totally independent measurements of the antenna height above the mark in both metric and English units must be made before and after each session. Someone other than the observer must check the measurement computations by carefully comparing measurements and then entering his/her initials on the log.

Some GPS antennas have detachable ground planes and radomes. In order to help identify what exactly was used at a particular site, it would be useful to have a snapshot of the setup. All co-observers should take a photograph of the setup, if possible, with a close-up of the antenna as viewed from the side.

In addition, a rubbing of the stamping of the mark must be made at each visit to a station. If it is impossible to make a rubbing of the mark, a plan sketch of the mark must be substituted, accurately recording all markings.

Also, for each station visited, a visibility obstruction diagram must be prepared and the TO-REACH description carefully checked for errors or omissions.

Lastly, the following must be recorded at each occupation of a station:

- (1) receiver manufacturer,
- (2) antenna manufacturer,
- (3) receiver model number (part number),
- (4) antenna model number (part number),
- (5) the complete serial number of the receiver, and
- (6) the complete serial number of the antenna.

Success of this project requires that the highest quality GPS data be collected. Therefore, during each station occupation, the operators shall carefully monitor the operation of the receivers. Any irregularities in the data due to equipment malfunction, DOD adjustment of the satellite orbit, obstructions, etc., must be reported to the Field Operations Branch, N/NGS41, as soon as possible and noted on the observing log. If the quality of observations for an observing session is questionable, notify the Field Operations Branch immediately.

The survey team shall not depart the project area until they have quality reviewed all data, advised N/NGS21, and notified N/NGS41.

GPS DATA:

Visibility tables and plots of the present satellite constellation for August 16, 2000, have been reviewed and two observing windows selected. For operational use, current data

must be generated with Trimble mission planning software or from program SATMAP.

A project report and data listed in Annex L of "Input Formats and Specifications of the NGS Data Base" and in the attached addendum for the adjustment portion of the project must be transmitted. Any data considered suspect as to quality in achieving accuracy standards should be sent via FedEx immediately for office review. Backup of transmitted data must be held until notified by the Field Operations Branch, N/NGS41.

The data set collected during the project shall be named "maro080d.791". All records in connection with this project shall be titled "MASSACHUSETTS, CONNECTICUT, AND RHODE ISLAND FBN, 2000". The project number (accession number) is GPS-1514.

LIAISON:

Liaison must be maintained with designated offices at the National Geodetic Survey headquarters located at:

1315 East-West Highway
Silver Spring, Maryland 20910-3282

Questions and problems concerning survey field operations should be directed to:

William T. McLemore, Jr.
Chief, Field Operations Branch
Observation and Analysis Division
N/NGS41, SSMC III, Station 8564
Telephone: 301-713-3215, ext. 117
Fax: 301-713-4327
e-Mail: Bill.Mclemore@noaa.gov

Questions and problems concerning adjustment processing should be directed to:

Maralyn L. Vorhauer
Observation and Analysis Division
N/NGS41, SSMC III, Station 8562
Telephone: 301-713-3176, ext. 104
Fax: 301-713-4327
e-Mail: Maralyn.Vorhauer@noaa.gov

Questions and problems concerning vector processing should be directed to:

Juliana Blackwell
Field Operations Branch
Observation and Analysis Division
N/NGS41, SSMC III, Station 8458
Telephone: 301-713-3215, ext. 108
Fax: 301-713-4327
e-Mail: Juliana.Blackwell@noaa.gov

Questions and problems concerning using CORS data in processing should be directed to:

Neil Weston
Geosciences Research Division
N/NGS6, SSMC III, Station 9830
Telephone: 301-713-2847, ext. 202
Fax: 301-713-4475
e-Mail: Neil.D.Weston@noaa.gov

Questions and problems which could affect the technical adequacy of the project should be directed to:

Stephen J. Frakes (Douglas R. Hendrickson)
Chief, Project Development Branch
Spatial Reference System Division
N/NGS21, SSMC III, Station 8853
Telephone: 301-713-3194, ext. 111 (ext. 127)
Fax: 301-713-4316
e-Mail: Steve.Frakes@noaa.gov
(Doug.Hendrickson@noaa.gov)

The coordinator for the CBN in Massachusetts is the NGS Geodetic State Advisor:

Mr. Curt Crow
Massachusetts Highway Department
Ten Park Plaza, Room 7410
Boston, Massachusetts 02116
Telephone: 617-973-8466
Fax: 617-973-8038
e-mail: clcrow@aol.com

Federal Express Address
4 Arnold Drive
Bow, New Hampshire 03304

The coordinator for the CBN in Connecticut is:

Mr. Bob Baron
Connecticut Department of Transportation
Unit 501, Room 4118
2800 Berlin Turnpike
Newington, Connecticut 06111
Telephone: 860-594-2510
Fax: 860-594-2678

The coordinator for the CBN in Rhode Island is:

Ms. Kathy Cheteyan
Rhode Island Department of Transportation
Survey Section
2 Capitol Hill
Providence, Rhode Island 02903
Telephone: 401-222-2815, ext. 4350
Fax: 401-222-1056
e-Mail: VCHETEYA@DOT.STATE.RI.US

Other CBN contacts in Massachusetts are:

Messrs. Todd Chapman, Ken Strom, and Scot MacDonald
BSC Group, Inc.
425 Summer Street
Boston, Massachusetts 02210
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Messrs. Eric Poreda and Mark Rohde
Coler & Colantonio
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Mr. Jim Wiswell
Surveying and Mapping Consultants, Inc.
170 Forbes Road, Suite 207
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e-Mail: jwiswell@smcsurvey.com

Mr. Dennis Pollock
Cuoco & Cormier Engineering Assoc., Inc.
150 Greenleaf Avenue
Portsmouth, New Hampshire 03801
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e-Mail: ccport@ix.netcom.com

Messrs. Richard Troupes and Jim Diorio
Vanasse Hangen Brustlin, Inc.
101 Walnut Street
Watertown, Massachusetts 02472
Telephone: 617-924-1770
e-Mail: richard.troupes@gte.net
jdiorio@vvhb.com

Other CBN contacts in Rhode Island are:

Messrs. Thomas Tait, Michael Gaston,
Terrence Greenlief, Malcolm Brownell, Kenneth
Fennessy, and John Oliver
Rhode Island Department of Transportation
Survey Section
2 Capitol Hill, Room 244
Providence, Rhode Island 02903

Messrs. Thomas R. Culligan, Geoffrey Hoogasian, and
James Brooks
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12 Breakneck Hill Road
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Telephone: 401-722-7660
Fax: 401-722-7530
e-Mail: cculligan@bryant-engrs.com

Mr. Eric Colburn, PLS
Foster Survey Company
8 North Road
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Telephone: 401-647-9240

Mr. Jeremy Webb
Commonwealth Engineers & Consultants, Inc.
400 Smith Street
Providence, Rhode Island 02908

Messrs. Phil Albert, Thomas Grala, and Terry Cote
Narragansett Bay Commission
235 Promenade Street, Suite 500
Providence, Rhode Island 02908
Telephone: 401-222-6680, ext. 388
401-580-1208 (cell phone)

Mr. Richard Nudenberg
Vanasse Hangen Brustlin, Inc.
530 Broadway
Providence, Rhode Island 02909

Mr. Elson W. Stanley, PLS
245 Sowams Road
Barrington, Rhode Island 02806

Mr. Alfred W. Diorio, PLS
264 Woodville Road
Hopkinton, Rhode Island 02833
Telephone: 401-377-8124
e-Mail: awd@loa.com

To obtain data from the Concord, New Hampshire, community base station, contact:

Mr. Kerrie Hartshorn
New Hampshire Department of Transportation
1 Hazen Drive
Concord, New Hampshire 03301
Telephone: 603-271-1600
Fax: 603-271-3914
e-Mail: Khartshorn@dot.state.nh.us

The contact for the Woburn, Massachusetts, community base station is:

Mr. Jim Bosworth
Maine Technical Source
110 Winn Street
Woburn, Massachusetts 01801
Telephone: 617-932-8888
Fax: 617-932-0450

The contact for the Newington, Connecticut, community base station is:

Mr. Bob Baron
(see CBN coordinator for Connecticut
above for address)

The contact for the Providence, Rhode Island, community base station is:

Ms. Kathy Cheteyan
(see CBN coordinator for Rhode Island
above for address)

To obtain data from the Kingston, Rhode Island, community base station, contact:

Mr. Chuck LaBash
University of Rhode Island
9 East Alumni Avenue
Suite 5
Kingston, Rhode Island 02881
Telephone: 401-874-5406
Fax: 401-874-4561
e-Mail: Labash@edc.uri.edu

The contact for the Naval Station Newport CORS site (allow 3 or 4 days notice) is:

Mr. James Sprague
Department of the Navy
Engineering Division, Code 421
Public Works Department
1 Simonpietri Drive
Newport, Rhode Island 02841-1711
Telephone: 401-841-4250
e-Mail: jim.sprague@smtp.cnet.navy.mil

Another contact for the Naval Station Newport CORS site who can check on the equipment is:

Mr. Tim Kerrigan
Navy Station Newport
Fire Protection Division
1931 Peary Street
Newport, Rhode Island 02841
Telephone: 401-841-1980 (primary)
401-841-2225 (secondary)

The contact for the Westford CORS site (allow 3 or 4 days notice) is:

Mr. Arthur Niell
Haystack Observatory
Route 40
Westford, Massachusetts 01886
Telephone: 781-981-5416 (primary)
978-692-4764 (secondary)
Fax: 781-981-0590
e-Mail: aen@dopey.haystack.edu

A secondary contact for the Westford CORS site (at the same address) is:

Mr. Mike Poirier
Telephone: 781-981-5556 (primary)
978-692-4764 (secondary)

For tide site information, contact:

Mr. Bruce Servary
Center for Operational Oceanographic
Products and Services
Requirements and Development Division
N/OPS1, SSMC IV, Station 6425
1305 East-West Highway
Silver Spring, Maryland 20910
Telephone: 301-713-2897, ext. 183
e-Mail: Bruce.Servary@noaa.gov

Names and telephone numbers of local contacts are given in the station description material.

ADDRESS:

Keep N/NGS41 informed of the party's post office, physical address, and telephone number at all times.

PUBLICITY:

See "NGS Operations Handbook," Section 1.4.1.

EXPENSES:

FBN expenses for this project will be charged to task number 8K6D2000. Expenses for the CORS FBN/CBN ties will be charged to task number 8K6D4000.

TRAVEL:

Travel and per diem are authorized in accordance with Federal Travel Regulations, Part 301-11, Per Diem Allowances. Current per diem rates were effective January 1, 2000.

ACKNOWLEDGMENT:

Please acknowledge receipt of these instructions in your Monthly Report.

cc: N/NGS - D. Zilkoski*
 N/NGS - S. Misenheimer*
 N/NGS1 - G. Mitchell
 N/NGS1x1 - C. Crow
 N/NGS11 - S. Cofer
 N/NGS21 - S. Frakes
 N/NGS21 - R. Anderson
 N/NGS21 - D. Hendrickson*
 N/NGS22 - T. Soler
 N/NGS23 - V. Kammula
 N/NGS3 - E. Allen
 N/NGS4 - E. Wade
 N/NGS4 - M. Vorhauer
 N/NGS4 - D. Hoar
 N/NGS41 - W. McLemore
 N/NGS41 - J. Blackwell
 N/NGS5 - R. Snay
 N/NGS6 - N. Weston
 N/OPS1 - B. Servary
 FGCS Members*
 Bob Baron, Connecticut Department of Transportation
 Darek Massalski, Connecticut Department of Transportation
 Kathy Cheteyan, Rhode Island Department of Transportation
 Todd Chapman, BSC Group, Inc.
 Ken Strom, BSC Group, Inc.
 Scot MacDonald, BSC Group, Inc.
 Mark Boucher, Mauk, Boucher, & Heureux, Inc.
 Richard Gosselin, Boston Edison
 Joe McNichols, Norfolk County Engineering
 John Lonergan, Massachusetts Water Resources Authority
 Wayne Harrison, Cullinan Engineering
 Chris Nicholas, Meridian Engineering, Inc.
 Gary Fix, Foresight Land Services

(cc's continued)

Michael Chouinard, MassHighway
 Peter McManus, MassHighway
 Ken Chang, Bradford, Massachusetts
 Will Lanphear, Bradford, Massachusetts
 Daniel O'Driscoll, O'Driscoll Land Surveying
 Philip Chipman, HNTB
 Donald Oliver, HNTB
 Eric Poreda, Coler & Colantonio
 Mark Rohde, Coler & Colantonio
 Jim Wiswell, Surveying and Mapping Consultants, Inc.
 Dennis Pollock, Cuoco & Cormier Engineering Assoc., Inc.
 Richard Troupes, Vanasse, Hangen, Brustlin, Inc.
 Jim Diorio, Vanasse, Hangen, Brustlin, Inc.
 Thomas Tait, Rhode Island Department of Transportation
 Michael Gaston, Rhode Island Department of Transportation
 Terrence Greenlief, Rhode Island Department of
 Transportation
 Malcolm Brownell, Rhode Island Department of
 Transportation
 Kenneth Fennessy, Rhode Island Department of
 Transportation
 John Oliver, Rhode Island Department of Transportation
 Thomas Culligan, Bryant Associates, Inc.
 Geoffrey Hoogasian, Bryant Associates, Inc.
 James Brooks, Bryant Associates, Inc.
 Eric Colburn, Foster Survey Company
 Jeremy Webb, Commonwealth Engineers & Consultants, Inc.
 Phil Albert, Narragansett Bay Commission
 Thomas Grala, Narragansett Bay Commission
 Terry Cote, Narragansett Bay Commission
 Richard Nudenberg, Vanasse Hangen Brustlin, Inc.
 Elson Stanley, Barrington, Rhode Island
 Alfred Diorio, Hopkinton, Rhode Island
 Kerrie Hartshorn, New Hampshire Department of
 Transportation
 Jim Bosworth, Maine Technical Source
 Chuck LaBash, University of Rhode Island
 James Sprague, Department of the Navy
 Tim Kerrigan, Navy Station Newport
 Arthur Niell, Haystack Observatory
 Mike Poirier, Haystack Observatory

* first page only

**DATA TO BE SENT TO HEADQUARTERS RELATING TO
THE ADJUSTMENT PORTION OF
FBN/CBN PROJECTS**

Free adjustment in NAD 83 (UNIX run).

Plots of the free adjustment created by running "plotres_prompt.bsh" on a UNIX server. Plots require a printer that supports postscript. The output file (long.out) contains a list of residuals which may be sorted using the following commands:

```
vi long.out
:1,$ !sort +0.47 (sorts horizontal residuals)
:1,$ !sort +0.71 (sorts vertical residuals)
```

(OPTIONAL) Constrained horizontal adjustment holding NGS CORS positions and ellipsoid heights.

Final combined Blue Book file (ASCII required) with *86* records (GEOID99).

Final description file (ASCII required.)

Final G-file (ASCII required.)

OBSCHK output.* **

CHKDDESC output.*

OBSDES output.*

* Any errors or warning messages must be explained.
** Errors relating to incomplete *86* records are acceptable.